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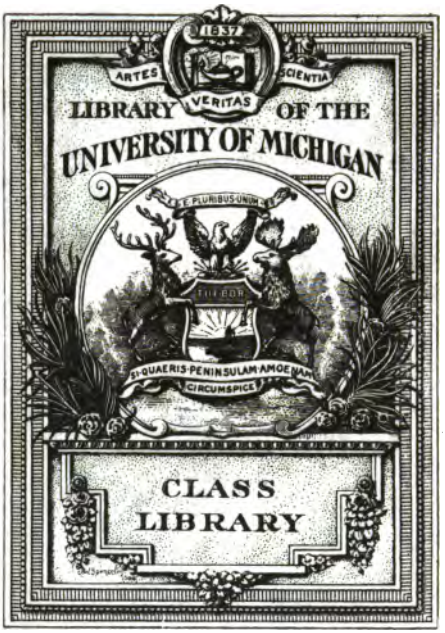

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BULLETIN No. 19.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF FORESTRY.

OSIER CULTURE.

BY

JOHN M. SIMPSON.

PREPARED UNDER THE DIRECTION OF

B. E. FERNOW,

Chief of Division of Forestry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.

FORESTRY DEPARTMENT
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., June 29, 1898.

SIR: I have the honor to submit herewith for publication a compilation of matter relating to the cultivation of osier willows, prepared by Mr. John M. Simpson.

Osier culture as a minor branch of forestry has been repeatedly referred to in the earlier reports from this division, when also a large number of species and varieties were introduced to test their adaptability to our climate. It was intended to await results from these importations before preparing the present manual on osier culture, but unfortunately the importations distributed to the agricultural experiment stations have mostly been lost without yielding any results as to knowledge of their usefulness as osiers in our country.

Osier growing may be profitably pursued just as any other business, but it requires as much knowledge of the peculiarities of the basket-making industry as of the technicalities of maintaining an "osier holt."

The author desires to give due credit in this report to the Divisions of Entomology and Vegetable Physiology and Pathology for "Notes on insect enemies" and "Fungous diseases" of the osier willow, and on behalf of the Division of Forestry, I cordially unite in this acknowledgment of the assistance thus kindly contributed by my colleagues.

Respectfully,

B. E. FERNOW,
Chief.

Hon. JAMES WILSON,
Secretary of Agriculture.

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OSIER CULTURE.

INTRODUCTION.

The willow-ware industry has been slowly increasing in our Eastern States of late years, but is yet in its infancy. The immense unutilized areas of land along our many rivers, portions of the seacoast, and of some uplands and prairies not suitable for any other agricultural pursuit, invite capital and energy to invest in osier growing, chiefly for the manufacture of basket ware.

According to the census report of 1880 there were in this country 304 willow-ware establishments, with a capital of $1,852,917, engaging 3,119 persons, paying annually the sum of $657,405 for wages, and producing manufactured willow goods to the amount of $1,992,851. The value of material consumed was $867,031, of which, however, only a small portion was produced in this country. In 1890 there were in the country 403 willow-ware establishments, with a capital of $2,702,713, engaging 3,732 persons, paying annually the sum of $1,269,135 for wages, and producing $3,633,592 worth of manufactured ware. The value of material consumed was $1,398,483, or an increase of 61 per cent over that used in 1880.

The imports in 1880 of manufactured willow ware, as reported by the United States Treasury Department, amounted to $142,213.98, and of osier or willow prepared for basket-makers' use, $21,833.

In 1890 the importations of manufactured willow ware were $372,-356.05, and of prepared osier or willow $27,646.05, an increase of 27 per cent over those of 1880.

Assuming that manufacturers include some other items under the head of material consumed besides prepared osier, the census increase of 61 per cent is probably a fair estimate of the increase in the amount of osier used in 1890 over that used in 1880; but, since the imports of prepared willow increased from 1880 to 1890 only 27 per cent, it is plain that the home production is increasing.

The fine willow ware used in this country is largely imported, for the reason that there is very little fine material grown here as yet, and our labor conditions are not suited to this industry, except in certain localities like Syracuse, N. Y., where the manufacture of salt is carried on largely in the summer, employing a great number of men who would be out of employment in winter unless they had basket making to fall back on. Very few basket makers work all the year round at

their trade. This is probably true, to a large extent, of other cities, like Chicago, Baltimore, Cincinnati, and St. Louis; besides, there are many farmers in our prairie States who could well engage in osier willow work during the winter season.

The importations of both prepared material and manufactured willow goods will be greatly reduced if the profit to be derived from a systematic production of osier becomes once better generally understood.

A large manufacturer of willow ware writes from Chelsea, Mass., that "ten years ago we used all imported willows, as there were not many willow growers here. We are now using about one-half ton a week, or 1,000 pounds of prepared willows; of this amount, about 300 pounds are French osiers and the rest are our home production."

HISTORICAL.

The importance of the willow to man has been recognized from the earliest ages. Ropes and baskets made from willow twigs were probably among the very first of human manufactures in countries where these trees abound. The Romans used twigs for binding their vines and tying their reeds in bundles and made all sorts of willow baskets. A crop of willows was considered so valuable in the time of Cato, two hundred years before the Christian era, that he ranks the salicetum or willow field next in value to the vineyard and the garden.

We find reference to the willow in Leviticus xxiii, 40, where it was used by the Hebrews to construct booths for the feast of tabernacles.

Theophrastus and Pliny speak of different sorts of willows, the latter describing eight species as among the most useful of *aquatic trees.*[1] The willow, Pliny says, "furnishes long props for supporting vines; and the young shoots of willows," he adds, "are much employed in basket making." The species which the Romans used for this purpose appear from Pliny's descriptions to have been the *Salix alba* or white willow; *Salix vitellina*, yellow willow; *Salix viminalis*, common osier, and the *Salix amerina* of Pliny and Delechamp, which was probably, as Dr. Walker thinks, the white willow of Theophrastus, and is certainly the *Salix decipiens* L., varnished willow. These kinds formed the osier holts of the Romans, and are still those principally cultivated for basket making throughout Europe at the present day.

In modern times "the many important uses," Sir W. J. Hooker observes, "rendered to man by the different species of willow and osier serve to rank them among the first in our list of economic plants."

The uses to which the osier may be applied are so varied that it would be impossible to attempt to enumerate them here. Being of a rapid and vigorous growth, it is peculiarly fitted for planting on the banks of rivers and streams for restraining their encroachments and retaining in its place the soil. In Holland an enormous number of willows are grown in the great river lowlands and along the margins of the meadow ditches for this purpose.

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[1] See explanation on page 9.

GEOGRAPHICAL DISTRIBUTION AND CHARACTERISTICS.

The genus Salix (the willow) is distributed over the whole earth. We find it under the Equator, and in the Arctic regions at the outermost timber line. It grows in low plains and in the snow regions of the Alps, in marshes and in pure sand, in compact clay soil, and in the clefts of the rocks. It is among woody plants what grass is among herbs.

ADAPTABILITY.

The willow accommodates itself, as no other plant does, to every soil, if not to every climate. This adaptability is made easy by a great variety of forms, such as are not possessed by other plants. The *Salix alba* (common white willow) is one of the largest trees; the *Salix herbacea* (least willow) is an herb of but a finger's length; *Salix pruinosa* (prune-leafed willow) produces in one year perpendicular shoots of more than 16 feet, while the shoots of *Salix repens* (creeping willow) creep miserably upon the ground. The pliant, slender rods of the *Salix viminalis* (common osier) and the *Salix purpurea* (bitter purple willow) grow among the high grasses and reeds of the river bank and are as flexible as these; the *Salix aurita* (eared willow) is to be found as a straggling shrub on the edges of the woods; the *Salix incana* (hoary-leafed willow) has awl-shaped leaves; the *Salix caprea* (great round-leafed willow) has broad leaves almost like those of an apple-tree; the *Salix myrtilloides* (myrtle willow) has smaller leaves than are those of the boxwood; the *Salix pentandra* (bay-leafed willow) and the *Salix longifolia* (long-leafed willow) have leaves as broad as a man's hand; the leaves of the *Salix viminalis* (common osier) are hairy like felt; those of the *Salix pentandra* (bay-leafed willow) are as glossy as if varnished. The roots of the *Salix caspica* (Caspican willow) attain the enormous length of 60 feet. The purple willows develop in clay soil such a mass of rootlets that the root appears like a bunch of hair. Thus by varied forms of the different organs the willow adapts itself to its habitat in all climates and in all parts of the world. While osier willows are easily satisfied in regard to both climate and soil, this does not imply, however, that the species best adapted to basket making prosper in every climate and in every soil.

THE TERM "AQUATIC" APPLIED TO WILLOWS.

The fact that the majority of willows grow in low lands in all countries, and are at least water-loving plants, has probably been the reason for terming them aquatic plants. While some species of the willow, like the Caspican, grow and thrive on dry sand and some others on high lands or even in the crevices of rocks, yet the majority of willows thrive best on ground where plenty of water is accessible. It is not to be understood, however, that they grow in the water or can survive any length of time under water.

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Willow seeds are armed with a woolly pappus, by means of which they are blown to great distances by the wind. If they fall where the soil is moist and loose, or are carried to such soil by the current of some stream, they sprout and grow immediately after ripening; but if they fall on high ground, they may sprout and grow for a time, the young plantlets being afterwards killed by the hot sun and drought; or the seeds may remain dry until their vitality is gone.

If, on the other hand, they fall or are blown into a river, stream, pond, or lake, they are carried by the water and stranded upon some sand bar, river terrace, or shore of the pond or lake, and find a congenial spot for growth, with shade from the banks, grass, reeds, etc., to protect the young plants from the hot sun. Hence we find the willow growing naturally along river terraces and on low lands in all countries.

Another cause to which is due in a measure the tendency of the willow to favor low-lying lands is to be found in the fact that the seed remain germinable only from forty-eight to eighty-five days or less under ordinary circumstances.[1]

OSIER HOLTS IN FOREIGN COUNTRIES.

The principal plantations of willows for basket making in every country are made along the banks of rivers and streams. In England those on the Thames and Cam are the most celebrated. In both of these rivers and in some others small islands are frequently planted entirely with willows, and are termed osier holts. There are many such islands in the Thames between London and Reading. The most extensive plantations of willows in fields are in the fenny districts of Cambridgeshire and Huntingdonshire, and perhaps the largest plantation in England is that of Mr. Adnam, near Reading.

One of the districts in Germany in which osier-willow culture and the basket-making industry have made most rapid progress is to be found in the valleys of the Wurm and the Roev near the borders of Holland. Twenty-five years ago there were not more than 70 acres of osier willows in the district; now all the large pasture lands are intersected by these plantations. The entire area planted amounted in the year 1882 to 1,393 acres; at present it is estimated at about 1,640 acres. Twenty-five years ago there were but very few basket makers in this district; now there are 952. A willow-weaving school was established here in 1876 with the object of producing thoroughly capable workmen in this department of industry. This school has already done excellent work and promises still better results for the future. The prosperity of the district which we have been considering has been greatly

[1] Seeds of *Salix pentandra* will remain germinable forty-eight days and will withstand a temperature of 0 degrees (zero) centigrade. Probably seeds of *Salix purpurea* may live eighty-five days.—(Botanical Centralblatt 39 (1889), pp. 150-151; Ref. Just's Jahresb., 1889, p. 14.)

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increased by the introduction of this new industry. The yearly gross income from the willow plantations has been $64,740, while the annual wages of the workmen, including willow weavers, have been more than $87,500.

Basket making in Germany represents a considerable capital, the exports of basket work amounting in one year to $1,143,500, employing nearly 40,000 persons annually, representing nearly $3,000,000 of capital, and using the growth of over 48,000 acres of willows, valued at $1,901,250 on the stocks, or nearly double that amount when peeled. When we consider that the soil devoted to osiers is generally little adapted for agricultural purposes and consequently of little marketable value, these figures represent an unusually high rent.

In Holland, Belgium, France, Germany, and many other European countries willows are planted largely as a protection to river banks. In these situations the income from the osier is a secondary consideration. The main object is to protect the river banks and to collect the silt by means of the willow bushes, which impede the current during high water, causing the sediment to be deposited, thus retarding the destructive flow of the river, and in time forming fertile meadow lands.

CHOICE OF VARIETIES.

The question as to what kinds of willow to plant is an extremely weighty one. An osier plantation set with an unsuitable kind of willow is a failure from the beginning. That this must entail a heavy loss is clear. Unfortunately, it is hardly possible for the planter to distinguish from descriptions the different varieties and hybrids.[1] Hence he is more or less at the mercy of unscrupulous dealers. What is more to be regretted is, that of the almost endless number of species, varieties, and hybrids the greater number are not valuable as osiers; and the value of quite closely related varieties differs greatly. Out of more than 250 species of willows and their numerous varieties and hybrids only a limited number have been found of economic value, especially for basket purposes. While the best varieties for European climates have

[1] Willows hybridize much more readily than many other plants, hence we find many hybrids among these trees. The honeybee is the principal agent which carries the pollen. The willow, flowering in the early springtime, before the snow is fairly gone in temperate latitudes, is a welcome store of sweets for the bee.

Some of the so-called varieties of willow, and some of the very best for basket-making purposes, are supposed to be hybrids.

Hybridization occurs among plants when the ovule of one plant is fertilized by the pollen of some other closely related species, and may also result from grafting, where the scion and stock mutually affect each other, giving rise to shoots which present a mixture of their respective characters, such being termed graft hybrids. In the first case hybridization is brought about by the pollen, or flower dust, being carried by an insect or the wind from the stamen of one flower to the pistil of another closely related species, the result of the crossing, if successful, being a plant partaking of the characteristics of both parent plants, which is called a hybrid.

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been established by careful experiment and long experience, we can not speak authoritatively yet as to the capabilities of our native willows.

The requirements for a good basket willow are that it produce many slender rods without branching, that these rods be soft and pliable and of a white color when peeled, and that the stocks produce vigorously for a long period of years. Of the European kinds the *Salix purpurea* (bitter purple osier) is mostly grown in the United States, but under the climatic conditions of some parts of our country it does not thrive as well as in Europe. The hot sun and cold winters seem to change the quality of the rods, reducing the pith to a minimum, while the desirable rod should have a large pith and be soft and pliable and when peeled show along the rod only small closed eyes, the open elongated eyes being a sign of weakness. In new introductions, especially in the Southern and Middle States, the softest kinds should be chosen, as they will harden by acclimatization.

NATIVE VARIETIES.

Such an authority as Dr. C. L. Anderson, of Santa Cruz, Cal., states in a letter to the Department of Agriculture that—

Our native California willows, especially those growing here at Santa Cruz and vicinity, answer very well for all purposes. Baskets, hoops, etc., are made from all varieties that have the habit of growing along our streams. There is a difference, however; *Salix laevigata* Bebb. (spotted leafed willow), *Salix lasiandra* Benth. (western black willow) and its varieties, and *Salix laseolepis*, var. *Bigelovii*, Bebb. (Bigelow willow), seem to be preferable. On wet prairies, from Illinois and Wisconsin northwestward, is found plentifully a variety, *Salix gracilis* (slender willow), of this species, the twigs of which are collected near Chicago by Germans and sold to dealers in that city. *Salix cordata*, var. *vestita*, Anderson (diamond willow, heart-leafed willow), common all the way across the continent, twigs stout, suitable for the heaviest kinds of basket work; bronze or yellowish green, often bright red when exposed to much sunlight; not so tough and pliant as those of *Salix sericea* (silky willow) and *Salix petiolaris* (long-stalked green osier). These all grow rapidly, are hardy, and the texture is sufficiently tough. There is a variety of *Salix lasiandra* (western black willow) that has not been sufficiently described. The branches are long, slender, and drooping, and have the appearance of the weeping willow. This variety is exceedingly well adapted to economic uses.

The late Prof. M. S. Bebb, of Rockford, Ill., the American authority on willows, in a lengthy letter on the subject of economically useful varieties, after reciting his failures with European species and varieties, says:

My strong conviction is that success in osier growing throughout the corn belt east of the Rocky Mountains will only be attained by making good use of plants adapted to the climatic conditions, and even then that the product will fall below the best European in quality. * * * *Salix purpurea* (bitter purple willow), in some of its forms most highly esteemed abroad for osiers, is checked by the midsummer conditions, but not to so great an extent as some other European species, and one form which you particularize, viz, *Salix purpurea pyramidalis* (bitter purple pyramid willow), I should regard as a hopeful subject. * * * Of willows indigenous east of the Mississippi River, I would name the following as perhaps

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the most promising kinds for future trial: *Salix sericea* (silky willow, common eastward), a bushy shrub, 6 to 10 feet high; branches reddish green or greenish, at length olive; twigs long, slender, and very tough, yet extremely brittle for an inch or two at base. *Salix petiolaris* (long-stalked green osier, common westward), near akin to the former, habit quite similar; twigs usually yellow or tinged with crimson; not so brittle at base.

SUCCESSFUL CULTURE OF THE RED OSIER.

From correspondence so far had with practical osier growers in the East, the species most successfully grown in the Northeastern States, and seemingly, too, in Georgia, is the *Salix purpurea*, commonly called the red osier; but which of the several varieties this is has not yet been established—probably *pyramidalis* (pyramid shaped).

The red osiers are of German origin, and are considered the most useful, making numerous pliant, thin, slender, evenly grown rods, without branches; especially adapted for binding and wattling purposes; growing well in a moist, but also in drier sandy soil, less so on compact soils, but again excellently on mucky soils. They are least affected by heat and cold, wet and dry. But compared with other kinds grown in Europe, their yield is somewhat inferior, giving a full crop only after the third or fourth year. Altogether vigorous growers are to be recommended, yet even on the best soils, with quick-growing kinds, the growth diminishes after a few years. In the selection of species it is not to be forgotten that while they must be adapted to climate and soil and be good and persistent producers, the kind of material furnished by them is to be kept in view, as different species and varieties differ in this respect.

SOME EUROPEAN WILLOWS.

Of European willows, varieties suitable for basket making and wattling are to be found only among the following species:

1. *Salix amygdalina* (almond-leafed willow).
2. *Salix lucida* (shining-leafed willow).
3. *Salix fragilis* (cracking willow).
4. *Salix caprea* (great round-leafed willow).
5. *Salix prunifolia* (plum-leafed willow).
6. *Salix viminalis* (common osier).
7. *Salix purpurea* (bitter purple willow).

Of the species numbered 2, 3, and 4, there are only a few varieties of osier willows. Of *Salix lucida*, only the variety *pentandra* can be used. This is a pliant and close-grained willow, but grows too small and weak for profit. Among the varieties of *Salix fragilis*, good binding willows are to be found. The species *Salix alba*, which has been erroneously confounded with *Salix fragilis*, produces shoots suitable for the common gray unpeeled baskets, but is generally grown as a tree or as a pollard.

One of the European osier willows, *Salix viminalis*, or common osier,

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has been grown in the grounds of the Agricultural Department for upwards of 30 years, during which time it has been thoroughly tested and found well fitted for basket-making purposes, producing numerous pliant, smooth, slender rods, without branches, from 6 to 8 feet long, without special care or cultivation, and it is almost free from insect depredations. Of the other European varieties of osiers growing here, but little definite information has been obtained. Having no proper facilities for osier growing, the Department of Agriculture must rely on private growers for any useful data along this line of agriculture; hence the introduction in this report of letters giving the practical experience of osier raisers.[1]

By the personal efforts of the Chief of the Division of Forestry, and through the favor of Heinrich Ritter von Manner, a prominent osier grower in Austria, a selection of rods of some seventy varieties was obtained in the spring of 1887, and cuttings from these were distributed to the various experiment stations.

The long journeys, and the consequent delay in reaching their destination, proved detrimental to a large number, and in most cases the experiment stations which have been heard from report entire failures. From those stations which were successful in raising the cuttings no definite information in regard to their adaptability to our climate or to their basket-making properties when grown under our hot sun have been received by the Department.[2]

SELECTION OF SOIL.

The soil for basket willows should be a deep, sandy loam, well drained, and thoroughly prepared. The situation ought to be low, level, and naturally moist; and if there is a command of water for irrigation, so much the better. The osier will prosper, however, in a somewhat dry soil, in which the shoots will not only be smaller, but harder, tougher, and more compact and durable than when grown in a soil that is rich and moist. In dry soils, also, the growth of the plant is much slower than when it has been impelled by an extraordinary supply of water. The best situation, when the object is free and rapid growth, is along the banks of rivers and brooks that pass through a level country and on the small islands which frequently occur in the midst of streams; hollows or swales also, the soil of which is composed of rich, soft, earthy particles, and which can be laid dry, furnish eligible sites for conversion into osieries; and if such can be occasionally soaked with water during the dry months of summer, the situation may be considered as perfect. Completely draining the site for a basket-willow plantation is the first step toward its formation and the foundation of its success, and consequently of the profit to be derived from it. There are hundreds of thousands of acres of marsh lands,

[1] See pages 25–27.

[2] See report of the Chief of Division of Forestry for 1889, page 285, from which, as well as from that of 1886, I have quoted extensively in compiling this bulletin.

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located principally in our upper lake regions, or in that section of our country known to geologists as the glaciated territory, at present not paying 2 per cent per annum, which might be drained at a small outlay and planted to willows, producing an immense profit. Business men are generally contented with an interest of 10 per cent per annum, while here is a business which will pay two or three times that amount if properly managed.

To make osier holts profitable, such soils should be selected as can not be otherwise used to advantage. Very poor soils, however, should be avoided, unless there is a good market for inferior material. The best soil is a fresh, black sand, but even a heavy, compact loam, or rich but sour meadow land, which produces the poorest quality of grass, is acceptable.

Peaty soil, if it can be covered with a layer of sand or loam (from the drain ditches), will produce a good growth.

The Caspican willow will thrive on the poorest sand. Planted on the banks of brooks, ponds, and ditches, it will secure the embankment and yield a good profit besides.

PREPARATION OF SOIL.

In preparing the ground for an osiery, if the soil be poor, it should be as well dressed with stable manure as if it were intended for a crop of barley or wheat. Lime as a fertilizer has been tried, but it was found that the twigs became much fired or spotted with a sort of canker, and in attempting to bend them they readily broke at the cankered spots.

In no case should a plantation be attempted but in prepared ground, except, perhaps, where a few rows may be introduced upon the brink of a river or on the top of the banks of ditches, which form in most instances the barriers of waters, where the soil can scarcely be dug or otherwise cultivated.

Plow or spade the ground 16 to 20 inches deep—deeper if the subsoil brought up would improve the ground (sand or loam below peat); less deeply if the soil is shallow and subsoil meager. Spading offers opportunity for burying the weedy surface more effectively.

Locations liable to late spring frosts should be avoided. Never plant on soil liable to be covered with stagnant water in summer. By making drains in such localities, however, good crops can be procured. Wet ground should be formed into raised beds of from 30 to 50 feet wide, leaving 2-foot ditches, by which the water is quickly drained off.

The water level, as shown by the bottom of these ditches, should be laid at least 1½ feet deep. In spading, care should be taken to bring the surface under and the subsoil on top. By this means the roots will be benefited by the vegetable mold of the surface soil and the subsoil at the surface will prevent a rapid running to weeds. For spring planting the soil must be prepared in the fall or early winter, so that it may be pulverized by the frosts.

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PREPARATION OF CUTTINGS—PLANTING.

The best time for planting is the late fall, generally the end of October. For such planting the soil should be prepared in the spring or early summer and left fallow.

If the spading has been done in fall or winter, the planting should be delayed till early spring. Then the growth of the cuttings is the more assured the less advanced the spring growth. To retard early growth, take the cuttings before growth starts and lay them in water. Use only lower half of main shoots for cuttings, because the tops would produce too weak material.

The best length for cuttings is about 12 inches. On compact, moist soils a length of 10 inches will suffice, while on dry sand and peat soils 14 to 16 inches may be taken, in order to get a larger number of roots in the first season—the number of roots being to some extent dependent upon the length of the cuttings under ground. Place cuttings in the ground so that the tops are even with the surface, but on compact and caking soil, which would hinder the buds from pushing through, leave two or three buds above ground. After the shoot is started it is well to draw the earth up to cover the entire cutting, as many dangers beset the top when left free—injuries in harvesting, from drying, and from insects. Take care to pack the soil closely around the whole length of the cutting. The practice of placing the cuttings inclined is without rational foundation. Cuttings for planting are best taken during winter, when vegetation rests, and may be taken from two, three, or even one year old wood, if of good size. The distance at which osiers are planted varies. Two considerations must be kept in view: The possibility of cultivating and working between the rows and the desirability of shading the ground as closely as possible, which keeps the soil moist and free from weeds, and to some extent from insects. A distance of 20 inches between the rows and of 4 inches in the row answers these purposes. If the stand be too thick, every alternate plant may be grubbed out after the third year. This system will require about 65,000 cuttings to the acre. Another method, which is preferred by some growers, is to set the cuttings 12 inches apart in the rows and the rows 3 feet apart; the cuttings are pressed down so that the top bud will be at least 1 inch beneath the surface; by this method the shoots grow straight upward from the ground, the lower portion of the rods not being bent or crooked as when grown from high stumps. By this plan of setting the ground can be plowed after the crop is gathered and the whole field afterwards well harrowed with a blunt-toothed harrow, so as not to tear or split the plants. By this culture the soil can be cleaned effectually at little cost, and the thorough culture will add to the vigor of the plants. Manure can also be readily applied, as the tops of the plants are so low that hauling wagons over the field does not injure them. This system would not require more than 15,000 cuttings.

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It should be borne in mind that, as a general principle, willows, to be of any use either as basket rods or hoop poles, must annually ripen their shoots, and that in cold climates this can not be done where they are grown in soil which is abundantly supplied with water late in the season. Hence the colder the climate the drier should be the soil after midsummer, on account of the necessity of perfectly ripening the wood. In regard to general management, few ligneous plants require so little care as the willow, when cultivated for timber or coppice wood; but considerable care is required where it is grown for hoops, rods, or wickerwork.

CULTIVATION.

In the first year cultivation should be delayed until the middle of June, to avoid disturbing the small rootlets. When cultivating, first mainly subdue the weeds and hill up the soil around the cuttings. Second and third weedings should be in August and September. Before winter sets in the plantation should be free from weeds. In the second and third year thorough cultivation is required. The first cultivation should then begin as soon as the frost is out of the ground. All cultivation must be shallow, not more than 2 inches deep, so as not to injure the roots, and must not be omitted even in dry weather, as a finely pulverized top soil formed by thorough cultivation prevents excessive evaporation of the moisture contained in the subsoil and saves the loss which must occur from long-continued drought.

FERTILIZATION.

There is no doubt that by top-dressing with manure or compost the yield can be increased largely, but it is mostly too expensive, as the material would have to be carried into the plantation by hand, especially in fall or spring on low grounds. As to fertilizers, mucky and peaty soils should not receive an increase of nitrogenous matter, though this is desirable on poor sands and meager loams. Phosphoric acid fertilizers improve the quality of the osiers; the cheap phosphorites, which are readily assimilated, are particularly desirable. Potash, forming a large part of the constituents of willows, is especially effective. Fertilizers are best applied during rainy weather and early in the season as soon as the rods have been cut.

HARVESTING.

Osiers should be cut the first year, even if no valuable material can be gotten. If the cutting is delayed until the second year, branching takes place and less valuable material is obtained. They should be cut in the second and third years also; but if there is a good demand for hoop poles they should be left uncut the fourth year to grow for hoop poles, reaching sufficient size for that purpose in from two to four years. If there is no demand for hoop poles, continue the yearly cuttings

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until the growth becomes too slim for basket purposes, which is generally from ten to fifteen years, when the osier holts must be renewed.

The cutting of rods should be done during winter, from November 1 to March 1; cut as near the ground as possible. Tie in bundles 10 inches in diameter and keep these bundles in running water, standing upright, 4 inches of the butts under water until small leaves or sprouts appear, when they will be ready to peel, the sap having started.

PEELING.

When it is intended to remove the bark by steaming or boiling, the willow bundles are set up anywhere until they are dry enough to be placed in stacks or stored in covered sheds until wanted. Willows peeled after the sap has started in spring are of a fine white color, while those which undergo steaming or the boiling process for the removal of the bark are of a dark-buff color, owing to their being stained by the coloring matter in the bark, which is dissolved and imparted to the wood by the heating process; but it is found that articles made of boiled willows are much more durable than those made from the white rods of spring peeling. Willows should never be cut when the sap is flowing, as the material obtained is poor, being too soft and turning black when peeled, besides permanently injuring the plants by robbing the roots of their yearly supply of nourishment. Cutting should never be done except with a sharp instrument, and in such a manner as not to split or mutilate the stocks.

Peeling is done by pulling the rods through a springy, wooden fork, shaped like a clothespin, but larger, with blunt edges inside, which, without injuring the willow, presses and loosens the bark in strands, which is then easily removed with the hands. The peeled rods are afterwards dried in the open air and put up in bundles of 50 pounds each for the market. The operation of peeling is so simple that it may be done by old persons unequal to any arduous labor at a stipulated price per bundle. In a peeled state the rods will keep better to await a market than if left with the bark on; and it is said that they never fail to produce a better return than when sold immediately after they are cut from the stocks.

FUNGOUS DISEASES.[1]

The fact that extensive plantations of one kind of product increase the number of their enemies, holds good for osier holts. Several kinds of fungous diseases occur on willows. The most destructive in this country are *Melampsora farinosa* (P.) Schroet, willow rust; *Uncinula salicis* (D. C.) Wint., powdery mildew, and *Cryptomyces maximus* (F. R.) Rehm., twig blight. *Melampsora farinosa* appears sometimes as early as the last of May or the first of June in small reddish or dark-brown

[1] Prepared under the supervision of the Division of Vegetable Physiology and Pathology.

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spots on the under side of the leaves, rarely on the upper side, of *Salix viminalis*, common osier; *Salix glauca*, glaucous willow, and a few other osiers, and spreads rapidly. Leaves that are affected soon become marked with dark blotches and fall off. Osier fields are sometimes entirely destroyed by repeated defoliation caused by this fungus.

PREVENTIVE MEASURES.

The best preventive measures consist in raking together and burning the fallen fungus-infested leaves from autumn till spring, and in careful attention to the osier field during summer. As soon as the rust appears in dark-brown spots on the leaves in late summer it is advisable to cut off and burn the worst affected shoots.

The next disease in importance is the powdery mildew, which spreads over the whole surface of the leaves, causing them to appear as if dusted with flour. If not checked, this fungus soon destroys any further growth of twigs for that year. Preventive measures for mildew are the same as for the willow rust. Doubtless, spraying with ammoniacal copper carbonate would also prove effective.

Rhytisma salicinum, or black spot, is very common, but so far as the writer is aware it never does very much damage. The principal remedy is to rake together all leaves which are spotted and burn them in the fall.

Cryptomyces maximus (twig blight) is likely to become an important disease. So far it has been reported on but two species of willow—*Salix purpurea* and *Salix sericea*. The only known remedy is to prune out the diseased wood and burn it.

The following notes on fungous diseases affecting the osier were prepared in the Division of Vegetable Physiology and Pathology, and will be of value to growers of this product.

NOTES.

Melampsora farinosa (P.) Schroet, Willow rust.

The two known stages of this disease (uredo and teleutosporic) can be recognized by their color. In the uredo stage small, yellow clusters in the spring or early summer are usually produced upon the under side of the leaves. Leaves so affected soon drop off, but before they fall the last, or teleutosporic, stage has begun to develop beneath the epidermis in numerous small, cushion-like bodies, at first pale brown and later dark brown. The spores produced in this stage, which occurs in late summer or autumn, pass the winter in the decaying leaves that lie on the ground, and are ready for an early spring development. This suggests the treatment, which consists of preventive measures—raking together and burning fallen leaves and cutting off infected shoots.

The fungus is quite common and at times very destructive, young trees being entirely destroyed by repeated defoliation.

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M. farinosa occurs on *Salix amygdaloides*, *S. arctica*, *S. caprea*, *S. cordata*, *S. cordata mackensiana*, *S. discolor*, *S. flavescens*, *S. glauca*, *S. lasiandra*, *S. longifolia*, *S. lucida*, *S. myrtilloides*, *S. rostrata*, *S. uva-ursi*, and *S. vitellina*.

Uncinula salicis (DC.) Wint., Powdery mildew.

This disease may be recognized by the white, dusty coating upon both sides of affected leaves during the summer, but toward autumn numerous minute black or brown balls are scattered among the cob-web-like threads of the earlier stage. The species is widely scattered, and occurs on many hosts, as follows: *Salix amygdaloides*, *S. caprea*, var. *pendula*, *S. cordata*, *S. discolor*, *S. flavescens*, *S. glauca*, *S. humilis*, *S. longifolia*, *S. nigra*, *S. petiolaris*, *S. rostrata*, and *S. sericea*.

Rhytisma salicinum (P.) Fr.

This fungus produces thickened, black, wrinkled spots or blotches on leaves. While it is of frequent occurrence, it is as a disease, of only relatively minor importance. It has been reported upon *Salix arctica*, var. *Brownei*, *S. discolor*, *S. flavescens*, *S. glauca*, *S. herbacea*, *S. humilis*, *S. longifolia*, *S. lucida*, *S. myrsinitis*, and *S. uva-ursi*.

Cryptomyces maximus (Fr.) Rehm., Twig blight.

This fungus attacks twigs, and causes their death above the portion where black, cushion-like fruiting bodies have appeared. These bodies originate in the lower bark and loosen the epidermal layers, causing the appearance of yellow spots. Black centers appear in the spots under the epidermis and these develop into the cushions. When the epidermis ruptures, these emerge and cover large areas of the living twigs. Rain causes them to become gelatinous and swell. On drying they fall off, leaving scars in the bark. This fungus has been reported upon *Salix purpurea* and *S. sericea*.

Cercospora salicina E. and E.

This species causes blackish spots upon both sides of the leaves, irregular in shape, more or less confluent, and so thickly scattered as to give the foliage the appearance of having been spattered with some dark liquid. It has been reported upon *Salix alba*, *S. longifolia*, and *S. nigra*.

Septoria.

There are three species of this genus reported upon American willows, but they can be determined only by microscopic examination, and it is probable that their differences are not sufficient to warrant specific separation. All cause numerous small spots of irregular outlines, light colored in their centers, with dark brown or purplish margin. These species have been collected upon *Salix cordata*, *S. glauca*, and *S. lucida*.

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Septogloeum salicinum (Pk.) Sacc.

"Spots large, irregular, indefinite, arid, pale." It occurs on leaves of *Salix lucida* and *S. sericea.*

Gloeosporium salicis, West.

Causes small, indeterminate, dark-colored spots upon the upper surface of leaves of *Salix longifolia.*

So far as reported, none of the four last-described diseases are very destructive. Raking and burning fallen leaves is the best preventive measure.

In place of the smooth-leafed varieties, such as *Salix rigida* and *Salix lucida*, which suffer most from fungi, the cultivation of the hybrid *Salix pruinosa* × *daphnoides*, or some other rough-leafed variety, is recommended. There is a somewhat generally prevalent impression that rough-leafed varieties are more resistant of fungous diseases than are the smooth-leafed. This has, however, never been scientifically demonstrated, nor, if there be such difference, have the causes of it been determined; hence experience may prove this impression to be unfounded.

NOTES ON INSECT ENEMIES.[1]

The various species of willow, including those with tough twigs suitable for basket-making, are greatly affected by insects, and the number of species of insects in Europe which live upon the willow is said by Kaltenbach to amount to 396. The number enumerated by Dr. A. S. Packard in 1890 as injurious to the willow in North America amount to 186.

In a general way it may be said that insects that attack the willow are to be found on all species of the genus, including the osier willows, and many also infest poplar and cottonwood as well. Among the most destructive willow insects are several species of sawflies, of which may be mentioned the American cimbex (*Cimbex americana* Leach), the yellow-spotted willow slug (*Nematus ventralis* Say), and two species known scientifically as *Dolerus arvensis* Say and *D. bicolor* Beauv.

The principal injury by sawflies is through the work of their larvæ in defoliating the trees. The mature insect of one species also does injury to the rods by gnawing a ring around the young branches, causing them to wither, making the field appear as if a fire had run over it. Work of the latter nature is effected by the willow-shoot sawfly (*Phylloecus integer* Nort.).

The remedy for this latter insect consists in pruning the tips of the shoots as soon as they begin to wilt, cutting them off about 2 or 3 inches below the point where the punctures girdle the stem.

For the American cimbex it is quite practicable, considering the small area to be protected and the conspicuous size of the insect and its clumsy movements, to catch the perfect flies by means of a net, but the application of arsenical poison is a surer measure and would serve

[1] Prepared under the supervision of the Division of Entomology.

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to rid the willows of many other insect enemies. An arsenical spray is all that is necessary to be used against the larvæ of the smaller sawflies.

An insect of growing importance as an enemy to willows, and one that is very destructive in this country, is the so-called streaked cottonwood leaf-beetle (*Megalosoma* [*Lina*] *scripta* Fab.). Another numerous and dangerous enemy of the willow, according to the late Dr. Riley, is a species of leaf-beetle related to and somewhat resembling the last, and known as *Galerucella decora* Say. These species of leaf-beetles devour the leaves both in the larva and adult stages, although they do the principal injury in the former state, often reducing the leaves by their numbers to mere skeletons. The best remedies for these latter insects, as well as for most species which injure the willow by defoliation, is one of the arsenical poisons—London purple or Paris green.

Several species of wood-boring beetles attack willows, but as a rule they seldom occur in sufficient numbers to do noticeable damage.

Plant-lice and bark-lice often do considerable injury to willows, the plant-lice or aphides being particularly troublesome. The remedy to be employed against this class of insects is kerosene emulsion, administered in the form of a spray upon the first appearance of the insects on the trees.

A complete list of insects known as infesting the willow up to the year 1890, with detailed accounts of the different forms, will be found in Dr. Packard's report on insects injurious to forest and shade trees (Fifth Report U. S. Entomological Commission, 1890).

MANUFACTURES.

The manufacture of willow ware is performed principally by hand labor in all countries, hence it is often termed a "house industry," being carried on in the homes of the basket makers, where the men, women, and children engage in peeling and splitting the rods and weaving the baskets under contract. The manufacturer pays for his articles—baskets, hampers, chairs, etc.—by the dozen, the basket weaver furnishing his own material, either raising it on leased land or buying it from large growers or importers. The willow goods produced in this country at present are mostly the coarser kinds, owing to a scarcity of skilled workmen in this line of industry and to the small amount of fine osier grown here.

The United States consumes the largest amount of willow ware of any country in the world. Our imports of fine ware from one district in Germany for 1893, in spite of the dull state of trade then existing, amounted to $230,000. This item was reported by Commercial Agent Louis Stern in the Consular Report for April, 1894.

Willow baskets, hampers, chairs, etc., have become an industrial article for which there is to-day an enormous demand. A prominent retailer in Washington, D. C., informed the writer that his annual

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sales are probably 60 dozen willow clothes baskets, 30 dozen hampers, 40 dozen scrap baskets, 25 dozen market baskets, 10 dozen nursery chairs, and 1 dozen willow trunks.

While the manufacture of osier or willow ware has been increasing steadily in this country, the demand is far greater than the supply.

Sawed-wood and split-wood baskets are used largely for shipping fruits, yet these can never take the place of the strong, light, and durable willow baskets for many other purposes. The willow-ware industry in the United States has received comparatively little attention for the reason that willow growing has been but little understood, labor has been high, and capital found many other channels for investment.

COST OF BASKET MAKING.

A practical willow raiser of Syracuse, N. Y., writing regarding his experience in osier growing, gives the cost of basket making as follows:[1]

In 1886 it is estimated that 5,000 persons were more or less engaged in the willow business in that region, and the manufacture amounted to 28,000 dozen baskets. One man will make 8 baskets per day, three sizes of clothes baskets—hardly any other are made. The price for making is from $1.70 to $1.80 per dozen. The average quantity of rods needed per dozen of the smaller baskets is 20 pounds, and a little more for larger ones. The total cost for basket making may be estimated as follows:

Cost of 1 ton green rods	$15.00
Steaming and hauling to and from steam box	2.25
Stripping the rods	8.00
Making into baskets (14 dozen)	26.00
Total cost	51.25
Cost of 1 dozen	3.67

As to yield of osier holts around Syracuse, N. Y., 4 tons of green rods per acre is an average crop, 6 tons a very good yield, and 8 tons have been occasionally obtained. The price per ton, green, has fallen from $20 to $15, while dry rods, peeled, will bring $60 per ton. For steaming $1 to $1.50 is paid, and for stripping $6 to $8; 2 to 2½ tons, green, will yield 1 ton of dry rods. Most of the rods are steam peeled, which causes them to lose their whiteness and makes them less valuable. Sap-peeled rods are superior, in color at least, but require more care, being less durable.

PRODUCTION AND PRICE OF OSIERS IN THIS COUNTRY.

The price for a good quality of dry hand-peeled rods is generally from 4 to 6 cents per pound. Steam-peeled rods bring somewhat less.

A large manufacturer of willow ware, Mr. Frank A. Parker, of Rochester, N. Y., writes to the Department on June 28, 1898, as follows:

* * * We have in our locality about 175 people employed in making willow baskets. This number includes men, women, and children in the winter. In summer the number is down to at least 150. In our immediate locality there is in the neighborhood of 200 acres of willows. Most of our basket makers lease land and

[1] See report of the Chief of the Forestry Division, Department of Agriculture, for 1889, page 288.

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grow their own willows, many of them raising enough for their own use without having to buy from others. Each family has a steaming apparatus of their own for preparing their own material, most of them devoting one day each week to this work, except in extremely warm weather during the months of July and August. The devoting of a day each week to this work up to that time leaves a little surplus, so that they get through these months without much steaming, on account of the willows having to be taken care of before that time. The cost of our willows per ton varies according to the crop, just as any other crop varies in cost. Willows are subject to many fatalities, like the stings of insects, hailstorms, etc. Where an insect stings a willow, or a hailstone strikes it, it will start a branch, and branchy willows are not good for baskets.

Osier plantations must be carefully cleaned[1] and hoed every year in order to obtain the best results. Nothing contributes more to the raising of a good crop of twigs, after due preparation of the soil, than keeping them clean. The stools should be annually attended to from the first year of cutting a crop of twigs, by clearing the rotten stumps and not allowing the plants to be overcrowded by the young shoots at their base. When these have become too numerous, they should be carefully thinned out and the remaining twigs cut back, leaving only one or two eyes at the bottom of each, until they are reduced to such a number as the stool is capable of vigorously supporting until the fall of the leaf.

A basket maker finds one shoot of 6 to 8 feet in length of more value than four of 3 feet in length; and one of the former of these dimensions will not so much exhaust the stool nor the land as four of the latter.

PROPER TIME TO THIN THE PLANTS.

The proper season for cleaning and thinning the stocks is in March or April, or a month or six weeks before the osier puts forth its leaves. The reason for choosing this period for the operation is, that if it were performed in autumn the latent buds existing at the base of the small shoots that have been cleaned off would swell in the course of the winter and be liable to throw out shoots in the following spring, whereas by delaying the cutting till the sap is in motion, these buds remain dormant and the whole current of sap is taken up by the buds already formed. The cleaning of the plants may be done with a sharp knife, and if it has been regularly attended to from the commencement of the plantation it is neither troublesome nor expensive. Indeed, this care is deemed necessary were it only for guarding the plants from the ravages of insects.

PRESERVING THE PRODUCTIVENESS OF OSIER HOLTS.

If the production of wands is alternated with that of hoop poles, the productive power of a willow plantation may be greatly prolonged, a matter of great pecuniary importance. The hoop poles are only cut every three or four years. Whether to cut wands and hoop poles

[1] "Cleaned" in this connection means the careful pruning of the stocks.

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alternately, or to cut the growth twice or three times as wands and then allow them to grow to hoop poles, depends on many circumstances, the most important of which is the demand for hoop poles mentioned heretofore. If managed for hoop poles and switches alternately, a plantation on soil not too poor may be kept in good yielding condition for twenty-five years. If the willow grove were left to nature, its annual crop of leaves would be sufficient to keep the land in good fertility, but by cutting annually for rods the crop of leaves is reduced to a minimum and the plants are reduced in vigor. Hence the growth becomes less from year to year until the crop is not fit for use, being too small and spindling.

EXPERIENCE OF AMERICAN GROWERS.

Messrs. A. Meinecke & Son, of Milwaukee, Wis., in a letter to the writer, state their experience in growing willows and manufacturing willow ware, as follows:

Continual inquiry is made regarding basket willows, and considering the favorable market price they bring it is remarkable that so few farmers undertake the cultivation of the same. Although this useful plant prospers well in this country, large quantities of willows are imported every year from Europe. Not every farmer may be in position to cultivate willows on a large scale, but most every one has a spare piece of land where he can plant some without expending much labor.

* * * Willow raising is certainly the most profitable and practical side cultivation, as the attention required by it is very simple in comparison with many other plants on which the profits are certainly much smaller. * * * The willow reaches its greatest production in the third year, and with proper care and good fertilizing it will continue to yield good results for many years. Dry, peeled willows are worth 5 cents a pound delivered in Milwaukee.

PROFIT OBTAINED FROM ONE ACRE.

The following illustration may serve to show the profit obtained from the production of 1 acre of willows:

One acre, only moderately well cared for with fertilizer, will yield at least 4 tons of green willows. This is the smallest amount, as many acres yield 7 tons.

Of these 4 tons, two-thirds may be deducted for bark and moisture, leaving about

2,666 pounds dry willows, at 5 cents a pound		$133.30
Wages would amount for cutting of 4 tons, at $5	$20.00	
Peeling of 2,666 pounds, at 1¾ cents for large and 2 cents for small willows	50.00	
		70.00

This leaves a profit per acre of $63.30, which is very favorable compared with that of wheat, rye, barley, and oats, and it would be advisable for every farmer to undertake at least the cultivation of one-half or 1 acre.

In former years the American farmer was able to obtain a higher price for his willows, owing to the fact that the manufacturer then received considerably higher prices for his goods.

On account of the constantly growing competition among manufacturers they were obliged to look around for cheaper material. Willows were imported from Europe in large quantities, which discouraged some farmers and induced them to give up the cultivation of willows altogether.

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The above illustration plainly shows that the willows can be delivered for 5 cents a pound. This price is equal to imported willows, including freight and duty of the latter, and gives the American farmer a chance to compete with European producers.

OSIER GROWING FOR PROFIT.

Nevertheless, osier growing for profit is not so simple and easy or inexpensive an enterprise as might at first appear. The market for the material is the first point to be considered, and in connection with it the kinds that will grow successfully and profitably in the locality under consideration. So far it seems that the climate of the United States in most parts, with its long hot summers, is not very favorable to the growth of the finer grades of osier rods, at least of the European kinds, which, with one exception, *Salix purpurea*, var. *pyramidalis*, are pronounced unsuitable, while American willows are not yet sufficiently tested to warrant their extensive employment for osier holts.

It is to be understood that of the numberless varieties of willows not all are osiers suitable for basket work; and of those which grow rods fit for such work there are some adapted to coarse work only.

One of the largest manufacturers of willow goods in this country writes, regarding the peculiarities of his business, as follows:

My work in the willow line is somewhat peculiar. While I have a good many men working for me, still this work is all done outside in their own homes and under contract, where they are able to get help from the smaller children of the family in peeling and splitting willows. In this way we are able to do this work cheaper than we should be able to do it under one roof. I calculate to make my people buy their own stock, as far as possible, but when they are short, or liable to be short, I step in and supply the deficiency, so that they will have work all the time.

Our stock is grown in this vicinity. We use very little imported stock, as the goods we make are the common sort, such as clothes baskets, hampers, etc., and for these we use steam-peeled willows.

CULTURE AND ECONOMIC IMPORTANCE.

Another practical willow grower relates his experience relative to the culture and economic importance of the osier as follows:

Having planted a small number of willows on my place, using them for tying nursery stock, noting the market price for years, and having ascertained the annual product of a 5-acre lot of willows adjoining the nursery, I became satisfied that with proper soil and attention the willow crop would pay from $100 to $125 per acre each year after the second from the time of planting, and the annual expense for labor would not exceed $20 per acre each year.

In making my estimate of the large profit from growing osier willows I did not take into account the ravages from worms, having cultivated willows for so many years and never having experienced any loss from this source. I set out 5 acres of osier willows (*Salix viminalis*); they were planted on a soil of black muck, were kept clean and well cultivated; they attained a growth of 2 to 5 feet; were fine and thrifty. In the month of August there appeared on them a few black and yellow worms that fed on the leaves. These worms did little damage that year; the willows made a superior growth, and, although but one year from the cutting, I sold several tons for $10 per ton green and unpeeled. It is not usual to have any salable

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willows the first year and when the stools are two or three years old the willows make canes from 5 to 9 feet and command here from $20 to $25 per ton at the railroad depot. * * * Relying upon the statement of Dr. Fitch, to whom I sent specimens of the worms, that "it is not probable these worms will be a permanent detriment," I prepared 10 acres adjoining the first willow planting in the most thorough manner and put out 150,000 more willow cuttings. These grew finely; but, alas for human calculations! About June the worms came in myriads upon both plantations, denuding the young willows of foliage to such an extent that many of them died, and impeding the growth of the older ones so much that few of them were merchantable.[1]

LIST OF OSIER GROWERS IN THE UNITED STATES.

For the benefit of persons interested in osier culture a list of willow growers is herewith appended with their post-office addresses:

Mr. William Gleason, Liverpool, N. Y.; L. L. Thurwachter & Son, Syracuse, N. Y.; Mr. Fred Wyker, Liverpool, N. Y.; Mr. Frank A. Parker, Rochester, N. Y.; Mr. Adam Axtman, Liverpool, N. Y.; Mr. Chas. Scherer, Liverpool, N. Y.; Mr. B. Beutler, Detroit, Mich.; Mr. W. Gumser, Muskegon, Mich.; Mr. C. F. Uhlrich, Cincinnati, Ohio; Mr. L. Lohrig, Baltimore, Md.

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[1] These worms were identified by the late Dr. C. V. Riley, entomologist of the Department of Agriculture, and proved to be the larvæ of a black sawfly (*Nematus ventralis* Say). See page 21.

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